Unit 1: Physics on the Go

Question Number	Question	
1	Which of the following quantities is a vector?	
	Answer	Mark
	D	**1**

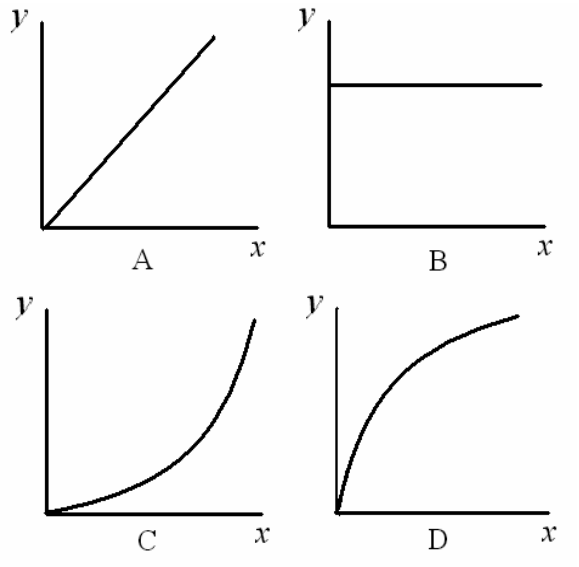
Question Number	Question	
2	Two wires made of the same material but of different lengths and diameters are joined end to end and used to support a vertical load. If the weight of each wire is neglected, each wire must have the same	
	Answer	Mark
	C	**1**

Question Number	Question	
3	Newton's third law tells us that	
	Answer	Mark
	D	**1**

Question Number	Question	
4	An athlete throws a javelin. Just as it hits the ground the javelin has a horizontal velocity component of 20 m s^{-1} and a vertical velocity component of 10 m s^{-1}. The magnitude of the javelin's velocity as it hits the ground is	
	Answer	Mark
	C	**1**

Question Number	Question	
5	In questions 5 – 6, which of the following statements best completes the sentence. A decreases linearly from zero B increases from zero to a maximum C increases linearly from zero D stays constant at a non-zero value If air resistance is neglected, the horizontal velocity component of an arrow fired from a bow……with distance travelled	
	Answer	Mark
	D	**1**

Question Number	Question	
6	The velocity of a ball bearing falling from rest through syrup……. with distance fallen	
	Answer	Mark
	B	**1**

Question Number	Question	
7	In questions 7 – 8, which of the following graphs best represents the quantities described when they are plotted on the *y*- and *x*-axes. Each graph may be used once, more than once or not at all.  **Variable on *y*-axis** / **Variable on *x*-axis** The kinetic energy of a car accelerating uniformly from rest / Displacement from starting position	
	Answer	Mark
	A	**1**

Question Number	Question	
8	**Variable on *y*-axis** / **Variable on *x*-axis** The acceleration of a feather falling near to the Moon's surface / Height above the Moon's surface	
	Answer	Mark
	B	**1**

Question Number	Question	
9	A shot putter launches the shot at an angle of 30^{o} to the horizontal. The throw is repeated with the same launch speed, but this time at an angle of 40^{o} to the horizontal. Which of the following is **not** correct?	
	Answer	Mark
	B	**1**

Question Number	Question	
10	Steel can be classified as a strong material. This is because	
	Answer	Mark
	B	**1**

Question Number	Question	
11	Complete the gaps in the following paragraph by selecting appropriate words from the following list. compressive density energy force mass stiff tensile tough Increasingly, drinks containers are made out of polymers rather than glass. A container made from a polymer such as polythene has several advantages over a glass container. Polythene has low ..... and so the .....of the container is kept low. Polythene is also .....and so can absorb a large amount of .....before breaking. Glass is only strong under ..... forces but polythene is also strong under ..... forces.	
	Answer	Mark
	density, mass (1) tough, energy (1) compressive, tensile (1)	**3**

Question Number	Question	
12(a)(i)	(a) (i) Determine $\frac{\text{kinetic energy of car travelling at 20 mph}}{\text{kinetic energy of car travelling at 30 mph}}$.	
	Answer	Mark
	Use of $E_k = \frac{1}{2}mv^2$ Correct answer [0.44] (1) Example of calculation: $\frac{E_{20}}{E_{30}} = \frac{(20)^2}{(30)^2} = 0.44$	**1**

Question Number	Question	
12(a)(ii)	(ii) To what extent does your answer support the claim?	
	Answer	Mark
	Collision energy is more than halved (1), so claim is justified (1)	**2**

Question Number	Question	
12(b)	A car of mass 1200 kg is in a crash. The front bumper of the car deforms, and the car is brought to rest from an initial speed of 10 m s^{-1} in a distance of 0.12 m. By considering the work done on the car as it is brought to rest, calculate the average impact force that acts. Average impact force =.....	
	Answer	Mark
	Calculation of collision energy [60 kJ] (1) Use of $W = Fx$ (1) Correct answer [500 kN] (1) Example of calculation: $E_k = \frac{1}{2}mv^2 = 0.5 \times 1200 \times (10)^2 = 60{,}000\text{J}$ $W = Fx$ so $F = \frac{W}{x} = \frac{60{,}000}{0.12m} = 500kN$	**3**

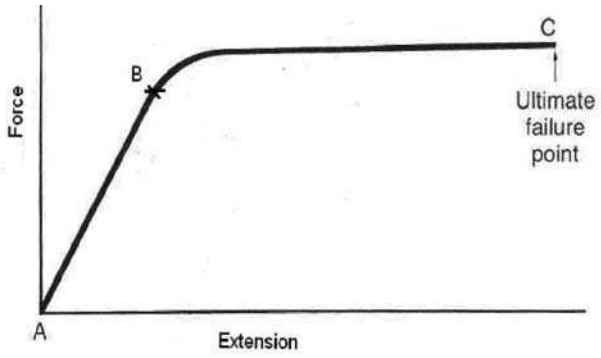
Question Number	Question	
12(c)	Modern cars include crumple zones to reduce the size of the impact force. Suggest how the crumple zones do this.	
	Answer	Mark
	Crumple zone increases displacement of car during crash so collision force is reduced **or** crumple zone increases collision time and so decreases the acceleration (and force) (1)	**1**

Question Number	Question	
13(a)	A skydiver accelerates towards the ground at 9.81 m s^{-2} at the instant that he leaves the aeroplane. Explain why his acceleration will decrease as he continues to fall.	
	Answer	Mark
	As skydiver speeds up, air resistance will increase (1) Net force on skydiver will decrease, reducing acceleration (1)	**2**

Question Number	Question	
13(b)	The skydiver opens his parachute. Explain why he reaches a terminal velocity shortly afterwards.	
	Answer	Mark
	Parachute greatly increases the size of the air resistance (1) When air resistance = weight of skydiver, skydiver is in equilibrium (1)	**2**

Question Number	Question	
13(c)	The velocity at which he then hits the ground is similar to that achieved when falling freely from a height of 3 m. Calculate this velocity.	
	Answer	Mark
	Use of $v^2 = u^2 + 2as$ **or** $\frac{1}{2}mv^2 = mg\Delta h$ (1) Correct answer [7.7 ms^{-1}] (1) Example of calculation: $v = \sqrt{2 \times 9.81 \times 3} = 7.7 ms^{-1}$	**2**

Question Number	Question	
14	A sign at a railway station advises passengers to keep back from the platform edge. This is because passing trains may cause turbulence.  Explain what is meant by turbulent flow, and suggest why it is dangerous for passengers to stand near the edge of the platform. You may be awarded a mark for the clarity of your answer.	
	Answer	Mark
QWC(i, iii)	Spelling of technical terms must be correct and the answer must be organised in a logical sequence Mixing of layers leading to eddies/ whorls (1) Air circulates around at edge of platform (1) Passenger may be pushed over due to eddies/ whorls (1)	**3**

Question Number	Question	
15(a)	The graph shows how a sample of material behaves when extended by a force.  What does point **B** represent?	
	Answer	Mark
	Proportional / Hooke's law limit (1)	**1**

Question Number	Question	
(b)	State the physical property represented by the gradient of the section **AB** of the graph.	
	Answer	Mark
	Stiffness of sample (1)	**1**

Question Number	Question	
(c)	Explain the significance of the area underneath the line from **A** to **C**.	
	Answer	Mark
	Work done / strain energy (1) To stretch (OR strain) wire to fracture (1)	**2**

Question Number	Question	
16(a)	A raindrop has a radius of 0.70 mm. It is falling at terminal velocity through air. (a) Show that the mass of the raindrop is approximately 1×10^{-6} kg. Density of water = 1000 kg m^{-3}.	
	Answer	Mark
	Use of $\frac{4}{3}\pi r^3 \rho$ (1) Correct answer [1.44 x 10^{-6} kg] (1) Example of calculation: $m = \frac{4}{3}\pi r^3 \rho = \frac{4}{3}\pi\left(0.7\times10^{-3}\right)^3 \times 1000 = 1.44\times10^{-6}\,kg$	**2**

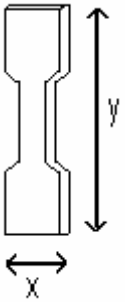
Question Number	Question	
16(b)	Ignoring any upthrust on the raindrop, calculate its terminal velocity. Viscosity of air = 8.90×10^{-4} kg m^{-1} s^{-1}	
	Answer	Mark
	Use of $mg = 6\pi\eta rv$ (1) Correct answer [1.2 ms^{-1}] (1) Example of calculation: $v = \frac{mg}{6\pi\eta r} = \frac{1.44\times10^{-6}\times9.81}{6\pi\times8.90\times10^{-4}\times0.7\times10^{-3}} = 1.2\,ms^{-1}$ (2)	**2**

Question Number	Question	
17(a)	Discuss the student's answer, highlighting any incorrect or missing physics.	
	Answer	Mark
	Reference to free fall whilst bungee is slack Idea of KE increasing as GPE is transformed Idea of work being done against frictional forces GPE converted into EPE (and KE) once bungee stretches KE (and GPE) converted into EPE beyond equilibrium point At lowest point all of the KE has been converted into EPE	**Max 4**

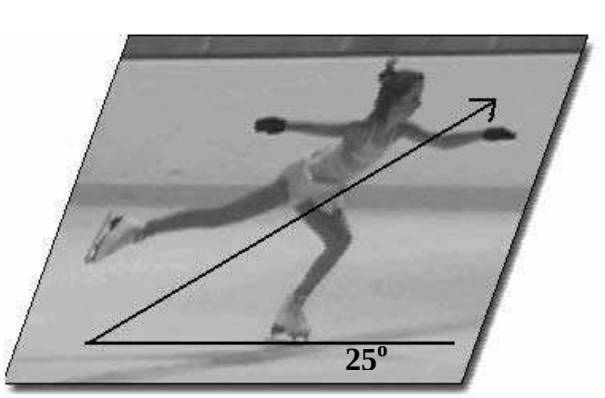
Question Number	Question	
17(b)	Calculate the acceleration of the jumper.	
	Answer	Mark
	Use of F=ma Correct answer [6.25 ms^{-2}] Example of calculation: $a = \frac{F}{m} = \frac{785-285}{80} = 6.25\,ms^{-2}$	**1** **1**

Question Number	Question	
18(a)	How long does the hammer take to fall 1.0 m from rest?	
	Answer	Mark
	Use of $s = ut + \frac{1}{2}at^2$ Correct answer [1.1 s] Example of calculation: $t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2 \times 1}{1.6}} = 1.1s$	**1** **1**

Question Number	Question	
18(b)	Calculate the velocity of the hammer just before it hits the ground.	
	Answer	Mark
	Use of $v = u + at$ Correct answer [1.8 ms^{-1}] Example of calculation: $v = u + at = 1.6 \times 1.1 = 1.8\ ms^{-1}$	**1** **1**

Question Number	Question	
19(a)	A tensile tester connected to a datalogger is used to investigate the effect of applying forces to a range of materials.   The sample has approximate dimensions ***x*** = 1 cm, ***y*** = 10 cm. It is fixed into the frame and force applied from a hydraulic system. The datalogger records the extension of the sample and the applied force. State any measurements, other than the force, that you would need to calculate the stress in the sample and name an appropriate instrument that you could use to make these measurements.	
	Answer	Mark
	Length and breadth of the thin cross section to calculate area (1) Digital callipers / micrometer (1)	**2**

Question Number	Question	
19(b)	Explain why access to a datalogger is useful when tensile testing is carried out	
	Answer	Mark
	• Small extensions can be measured accurately (1) • Large data set / easy processing of data (1)	**2**

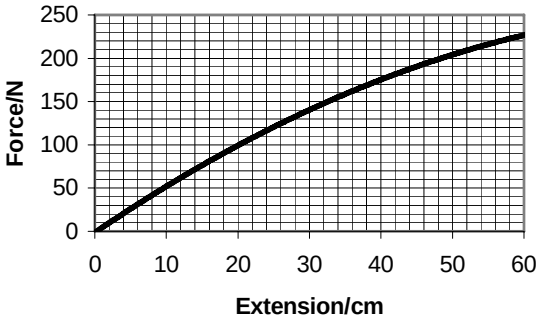
Question Number	Question	
20(a)	Performing complex jumps is an important aspect of a figure skater's program. Jumps with great heights and jump distances tend to leave a better impression with the judges, resulting in better marks for the skater. A skater of mass 60 kg leaves the ice with a velocity of 10 m s^{-1} at an angle of 25° to the horizontal.  Show that the vertical component of the skater's velocity is approximately 4 m s^{-1}.	
	Answer	Mark
	Use of $v \sin\theta$ (1) Correct answer [4.2 ms^{-1}] (1) Example of calculation: $v \sin\theta = 10 \sin 25 = 4.2\ ms^{-1}$	**2**

Question Number	Question	
20(b)	Calculate the time taken to reach the top of the jump Time taken =	
	Answer	Mark
	Use of $v = u + at$ (1) Correct answer [0.43 s] (1) Example of calculation: $v = u + at \quad 0 = 4.2 - 9.81 \times t$ $t = \frac{4.2}{9.81} = 0.43\ s$	**2**

Question Number	Question	
20(c)	Calculate the maximum height reached. Maximum height =	
	Answer	Mark
	Use of $s = ut + \frac{1}{2}at^2$ **or** $s = \frac{(u+v)}{2}.t$ (1) Correct answer [0.90 m] (1) Example of calculation: $s = ut + \frac{1}{2}at^2 = 4.2 \times 0.43 - 0.5 \times 9.81 \times (0.43)^2 = 1.81 - 0.91 = 0.90\ m$ **or** $s = \frac{(u+v)}{2}.t = \left(\frac{4.2+0}{2}\right) \times 0.43 = 0.90\ m$	**2**

Question Number	Question	
21(a)(i)	A chest expander is used to build up the chest muscles.  One type of expander consists of five identical springs as shown. A student disconnects one spring and finds that applying a force of 6 N to it causes an extension of 5 cm. Calculate the force required to stretch a single spring by 50 cm, stating the assumption you have made. Assumption: Force =.....	
	Answer	Mark
	Assumption: spring obeys Hooke's Law (1) Use of $F = kx$ (1) Correct answer [60N] (1) Example of calculation: $\frac{F_2}{F_1} = \frac{x_2}{x_1}$ $F_2 = \frac{50}{5} \times 6 = 60N$	**3**

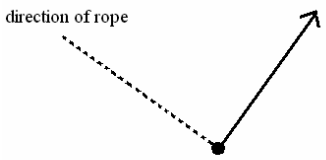
Question Number	Question	
21(a)(ii)	Calculate the work done when all 5 springs are stretched by 50 cm. Work done =.....	
	Answer	Mark
	Use of $W = F_{av}.x$ (1) Correct answer [75J] (1) Example of calculation: $W = F_{av}.x$ $W = 5 \times \frac{60}{2} \times 0.5 = 75J$	**2**

Question Number	Question	
21(b)(i)	A different type of chest expander uses rubber cords instead of springs. The variation of restoring force with extension for this expander is shown.  Use the graph to estimate the work done in extending the expander by 50 cm. Work done = ...	
	Answer	Mark
	Attempt at estimation of area under graph / average force (1) 0.5 m extension used (1) Correct answer [53 → 57J] (1) Example of calculation: Energy represented by 1 square =10 × 0.02 = 0.2 J 280 squares × 0.2J = 56J Treating the area as a large triangle $W = 0.5 \times 205 \times 0.5 = 51J$	**3**

Question Number	Question	
21(b)(ii)	When unloading the expander, it is found that at each extension the restoring force is always less than the loading force. Explain the significance of this, and describe what effect this would have on the rubber cords when performing a large number of repetitions with the expander.	
	Answer	Mark
QWC (i, iii)	Spelling of technical terms must be correct and the answer must be organised in a logical sequence Energy returned is less than the work done in stretching the cords (1) Energy must be conserved, so internal energy of cords must increase (1) Rubber cords will get warmer (1)	**3**

Question Number	Question	
22(a)	The photograph shows a climber abseiling down a rock face. At the instant shown the climber is in equilibrium.  Explain what is meant by equilibrium in this context. Weight =.....	
	Answer	Mark
	Idea that no resultant force acts (e.g. forces are balanced / cancel)(1)	**1**

Question Number	Question	
22(b)	The climber's mass is 65 kg. Calculate his weight.	
	Answer	Mark
	Use of w = mg (1) Correct answer [640 N] (1) <u>Example of calculation:</u> w = mg = 65 × 9.81 = 638 N	**2**

Question Number	Question	
22(c)(i)	Below is an incomplete free-body force diagram for the climber.  One of the forces, which is assumed to be acting perpendicular to the rope is already shown. Label this force, and add labelled arrows to the diagram to represent the other two forces acting on the climber. Assume that the rope hanging down from the climber exerts a negligible force on him.	
	Answer	Mark
	Tension in rope marked (1) Push from rock face marked (1) Weight marked (1)	**3**

Question Number	Question	
22(c)(ii)	The rope is at an angle of 40^{o} to the horizontal. Calculate the tension in the rope.	
	Answer	Mark
	Use of T = w.sin40 (1) Correct answer [410 N] (1) Example of calculation: T = w.sin40 = 640 ×sin40 = 410 N	**2**

Question Number	Question	
22(d)	The climber is wearing protective headgear in case of an accident. Describe the properties of a material suitable for the headgear, and explain why these properties are desirable.	
	Answer	Mark
QWC (i, iii)	Spelling of technical terms must be correct and the answer must be organised in a logical sequence Rigid/ stiff exterior to resist deformation under small forces (1) Must undergo plastic deformation under large forces (1) so that collision energy can be absorbed (1) Low density so that helmet is not uncomfortably heavy (1)	**4**